

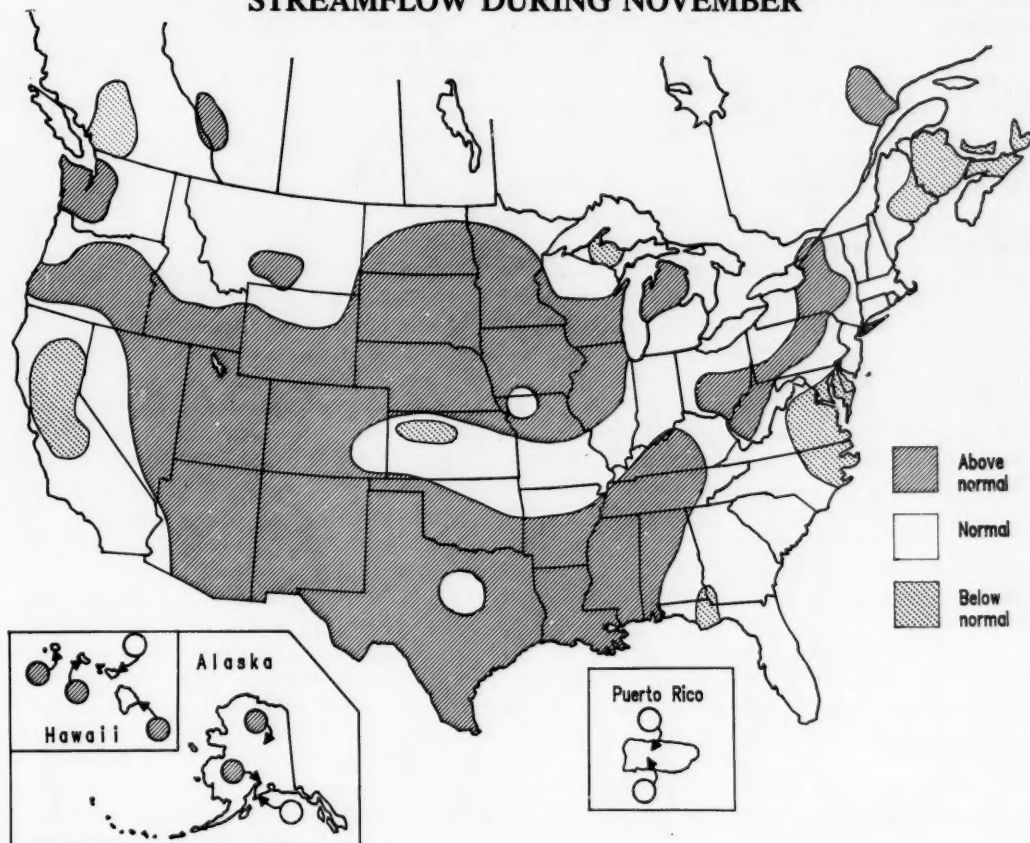
# National Water Conditions

UNITED STATES  
Department of the Interior  
Geological Survey

CANADA  
Department of the Environment  
Water Resources Branch

## NOVEMBER 1986

### STREAMFLOW DURING NOVEMBER



Severe floods occurred in Washington State November 23–25 as over 7 inches of rain fell in 24 hours in some areas. Chehalis River near Grand Mound peaked at 51,100 cubic feet per second (cfs), recurrence interval about 50 years, making it one of the four streams with peak discharges exceeding former peaks of record in the area.

Streamflow was in the normal to above-normal range at about 91 percent of the 192 index stations in southern Canada and the United States during November compared to 85 percent in those ranges for last month.

The combined flow of the 3 largest rivers in the lower 48 States—Mississippi, St. Lawrence, and Columbia—averaged a record-breaking 1,234,400 cfs during November (3 percent higher than November 1973), 85 percent above median, but 9 percent below last month's record-breaking combined flow.

Great Lakes monthly average levels for November remained well above median on all of the lakes and contents of 87 percent of reporting reservoirs were near or above average for the end of November.

## SURFACE-WATER CONDITIONS DURING NOVEMBER 1986

Severe floods occurred in Washington State (see map on page 3) November 23–25 as over 7 inches of rain fell in 24 hours in some areas. Chehalis River near Grand Mound peaked at 51,100 cubic feet per second (cfs), recurrence interval about 50 years, making it one of the four streams with peak discharges exceeding former peaks of record (see table on page 3) in the area. Two deaths were reported in Sultan, the town of Snoqualmie was partially evacuated, and some persons in the area of Sumner were evacuated. About 1,000 skiers were temporarily isolated near Mt. Baker when flood waters damaged bridge approaches because a river channel had silted in heavily (flood frequencies for peak discharges on streams in the area were on the order of 2 to 3 years), but a temporary bridge opened the area to travel. No damage estimates were available.

Streamflow generally increased seasonally in Hawaii, the Pacific Northwest, Nevada, Saskatchewan, South Dakota, most of the area between Arkansas-Louisiana and the Atlantic coast, and also northward along the coastal States through Maine. Streamflow increased contraseasonally in Puerto Rico, increased variably in Georgia and New Mexico, and changed variably in Utah, Arizona, Nebraska, Pennsylvania, New York, Quebec, New Brunswick, and Nova Scotia. Streamflow decreased in the rest of southern Canada and the United States; seasonally in Alaska, British Columbia, Alberta, Montana, Colorado, Kansas, Oklahoma, Missouri, and Florida; contraseasonally in California, Idaho, Wisconsin, Michigan, Indiana, Ohio, and Vermont; variably in Wyoming, Texas, Ontario, Minnesota, Iowa, and North Dakota. The map on page 4 indicates areas where streamflow has persisted in the above- or below-normal range during November after being in a different range during October.

Streamflow was in the normal to above-normal range at about 91 percent of the 192 index stations in southern Canada and the United States during November (see table on page 10 for detailed breakdown), compared to 85 percent in those ranges for last month. The total of the mean flows at the 192 stations was 2,299,340 cfs for November,

79 percent above the total of the median flows, but down 12 percent from the total of the means for last month (2,605,280 cfs and 122 percent of median).

New maximum monthly mean discharges for November occurred at seven index stations (see table on page 4), most of them in the West. For example, the monthly mean discharge of 7,091 cfs on the Colorado River near Cisco, Utah, was the highest November flow in 75 years of record, exceeding that of November 1941 by 200 cfs.

The combined flow of the 3 largest rivers in the lower 48 States—Mississippi, St. Lawrence, and Columbia—averaged a record-breaking 1,234,400 cfs during November (3 percent higher than November 1973), 85 percent above median, but 9 percent below last month's record-breaking combined flow. Monthly mean flow of the St. Lawrence River at Cornwall, Ontario, was the highest for November in 126 years of record, averaging 337,900 cfs (36 percent above median) and was in the above-normal range for the 22nd consecutive month. Monthly mean flow of the Mississippi River at Vicksburg, Mississippi, averaged an above-normal 804,100 cfs (2nd only to the 825,000 cfs of November 1973) after a record-breaking October mean, while monthly mean flow of the Columbia River at The Dalles, Oregon, averaged 93,400 cfs (6 percent above median) and was in the normal range.

Provisional data from the National Weather Service show that precipitation was above average over most of the Nation during November (see maps on page 5), with record-high totals for November falling at: Hilo, Hawaii (34.93 inches); Roswell, New Mexico (1.88 inches); Brownsville, Texas (7.61 inches); Lake Charles, Louisiana (8.23 inches); Williston, North Dakota (1.15 inches). In sharp contrast, precipitation at five stations in Michigan was the lowest of record for November; Alpena (0.58 inches), Grand Rapids (0.95 inches), Houghton Lake (0.45 inches), Marquette (1.04 inches), and Muskegon (0.63 inches). Well below-average precipitation fell across the southwestern Great Lakes States, the central Great Plains, most of the Great Basin

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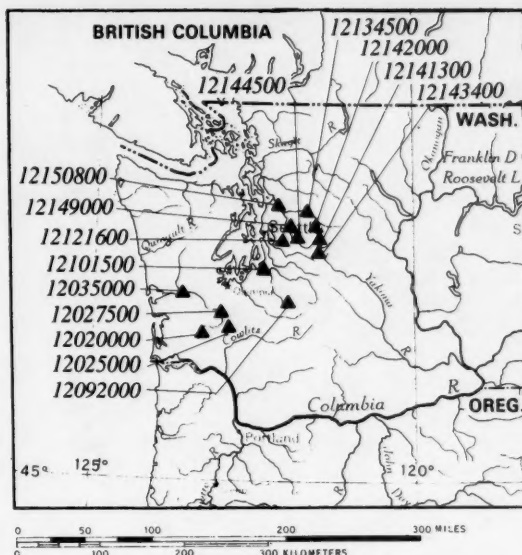
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and parts of California, Oregon, Washington, Texas, Florida, North Carolina, and Virginia.

Contents of 87 percent of reporting reservoirs were near or above average for the end of November, with 61 percent of reservoirs having contents significantly above average, including most of those in Vermont, Oklahoma, Texas, and Colorado. Most reservoirs (61 percent) had significant increases (more than 5 percent) in contents during the month. Only three reservoirs—First Connecticut Lake (Connecticut), Lewis and Clark Lake (South Dakota), and Pend Oreille Lake (Idaho)—had both a significant decline in contents during the month and below-average contents for the end of the month.

Hydrographs for eight large rivers located in the mid-continent are given on page 6. Flows at four of the sites have been in the above-normal flow range for many consecutive months: Red River of the North at Grand Rapids, North Dakota (19 months); Mississippi River near Anoka, Minnesota (19 months); Minnesota River near Jordan, Minnesota (15 months); Mississippi River at Keokuk, Iowa (15 months). Flow of the Mississippi River at St. Paul, Minnesota (hydrograph on page 10), which is just downstream from the confluence of the Mississippi and Minnesota Rivers, has been in the above-normal flow

(Continued on page 11.)



Location of sites in Washington for which flood data are given.

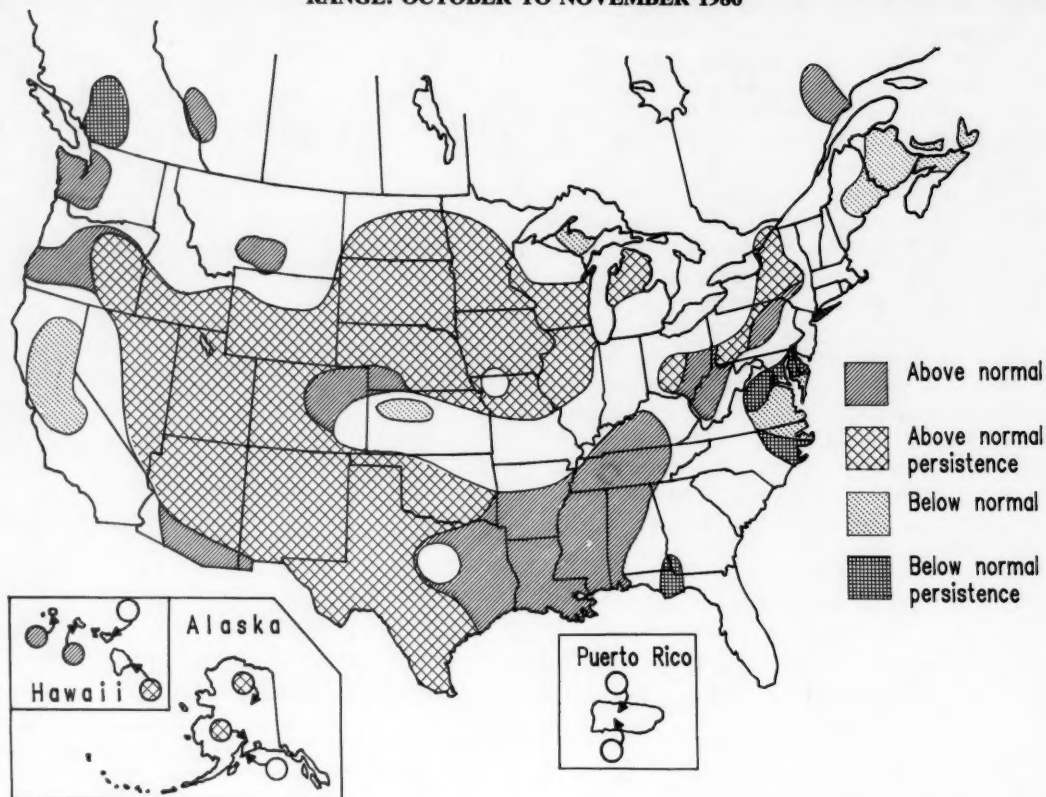
Provisional data; subject to revision

# FLOOD DATA FOR SELECTED SITES IN WASHINGTON, NOVEMBER 1986.

WRD station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known			Maximum during present flood				
				Date	Stage (feet)	Discharge (cfs)	Date	Stage (feet)	Discharge		Recur- rence interval (years)
									Cfs	Cfs per square mile	
CHEHALIS RIVER BASIN											
12020000	Chehalis River near Doty.....	113	1940-	Jan. 20, 1972	18.36	22,800	Nov. 24	16.31	17,900	158	20
12025000	Newaukum River near Chehalis.....	155	1930-31, 1943-81, 1983-	Dec. 2, 1977	12.49	10,300	24	12.76	10,700	69	50
12027500	Chehalis River near Grand Mound.....	895	1929-	Jan. 21, 1972	18.21	49,200	25	18.41	51,100	57	50
12035000	Satsop River near Satsop.....	299	1930-	Jan. 22, 1935	38.90	46,600	23	35.93	40,100	134	20
PUYALLUP RIVER BASIN											
12092000	Puyallup River near Electron.....	92.8	1909-33, 1945-49, 1958-	Nov. 22, 1959	<sup>a</sup> 11.9	10,800	24	7.64	9,010	97	15
12101500	Puyallup River at Puyallup.....	948	1915-	Dec. 10, 1933	31.0	57,000	24	27.80	42,400	45	40
LAKE WASHINGTON BASIN											
12121600	Issaquah Creek near Issaquah.....	56.6	1964-	Dec. 3, 1975	11.46	2,870	24	13.20	3,400	60	25
SNOHOMISH RIVER BASIN											
12134500	Skykomish River near Gold Bar.....	535	1929-	Dec. 26, 1980	21.38	90,400	23	19.90	77,100	144	15
12141300	Middle Fork Snoqualmie River near Tanner.....	154	1962-	Dec. 2, 1977	14.93	30,200	23	14.68	29,000	188	20
12142000	North Fork Snoqualmie River near Snoqualmie Falls.....	64.0	1930-60, 1962-	Feb. 26, 1932	<sup>a</sup> 17.5	15,800	23	12.32	12,600	197	10
12143400	South Fork Snoqualmie River near Garcia.....	41.6	1961-	Nov. 19, 1962	11.96	7,090	23	8.33	8,300	200	40
12144500	Snoqualmie River near Snoqualmie.....	375	1899, 1903-04, 1908-32, 1959-	Nov. 23, 1959	19.78	61,000	24	19.35	57,600	154	20
12149000	Snoqualmie River near Carnation.....	603	1929-	Feb. 27, 1932	59.88	59,500	24	59.82	56,500	94	20
12150800	Snohomish River near Monroe.....	1,537	1964-	Dec. 4, 1975	22.92	115,000	24	20.68	90,600	59	10

<sup>a</sup>Site and datum then in use.

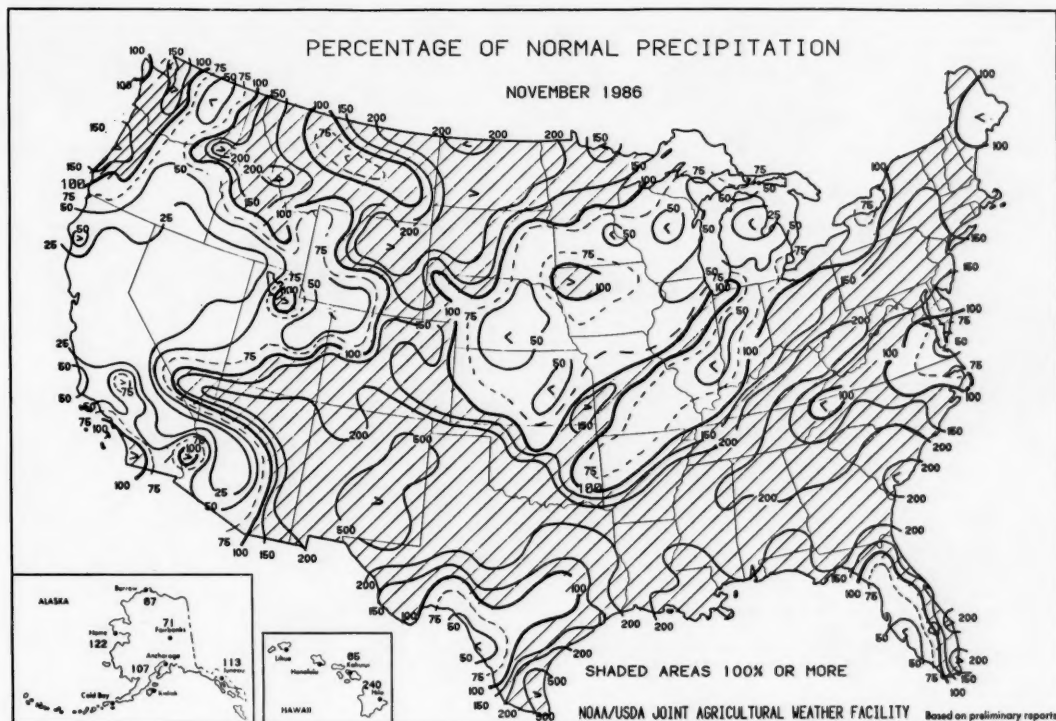
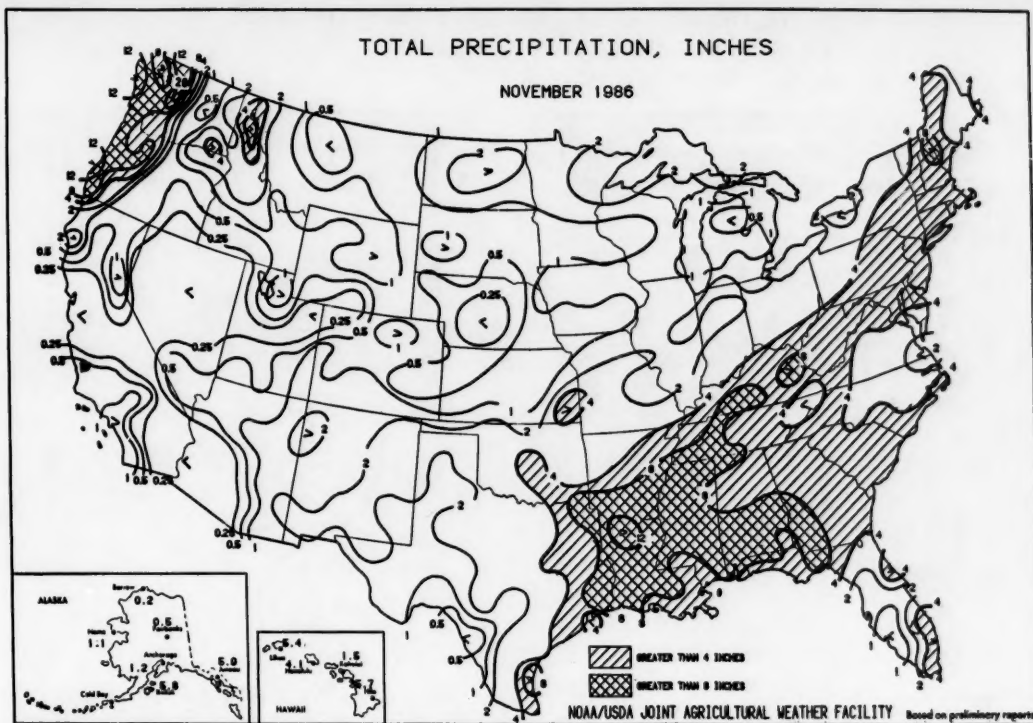
**PERSISTENCE IN, OR MOVEMENT INTO, THE BELOW-NORMAL OR ABOVE-NORMAL FLOW RANGE: OCTOBER TO NOVEMBER 1986**



**NEW MAXIMUMS DURING NOVEMBER 1986 AT STREAMFLOW INDEX STATIONS**

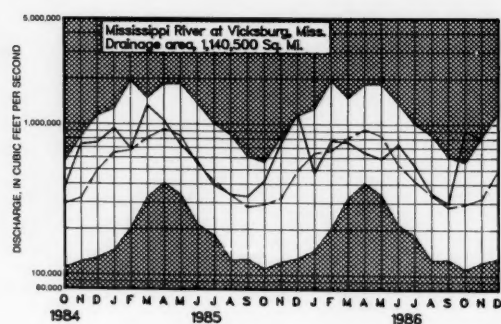
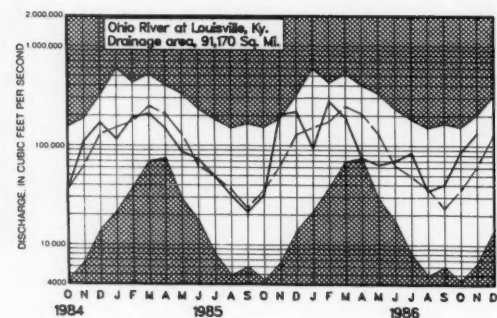
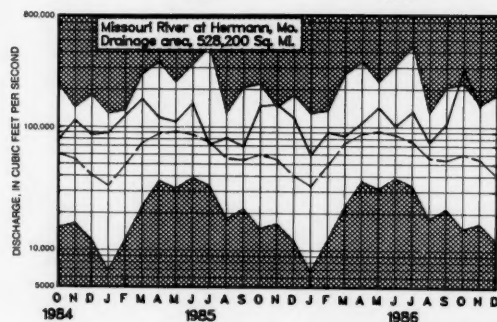
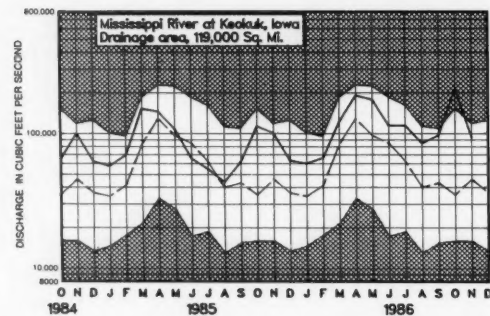
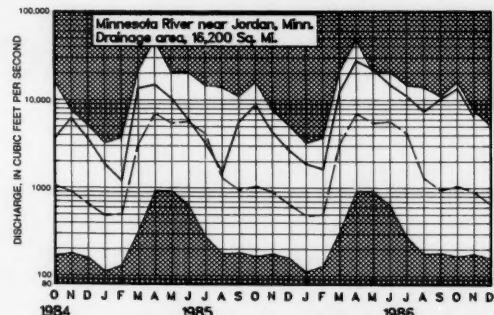
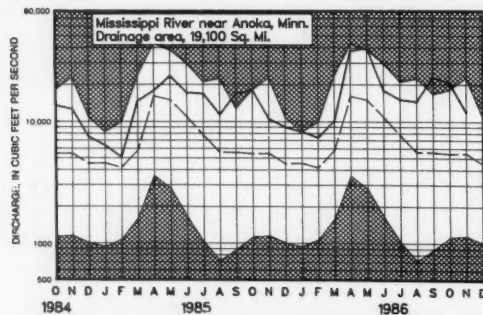
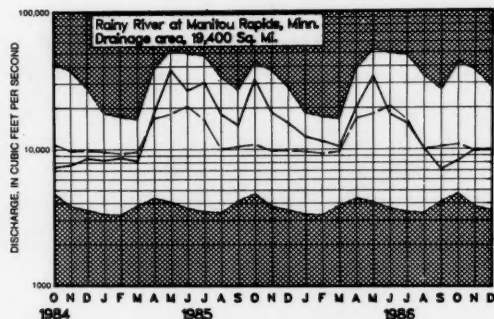
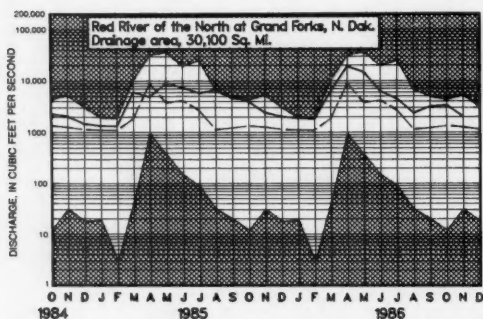
Station number	Stream and place of determination	Drainage area (square miles)	Years of record	Previous November maximums (period of record)		November 1986			
				Monthly mean in cfs (year)	Daily mean in cfs (year)	Monthly mean in cfs	Percent of median	Daily mean in cfs	Day
04264331	St. Lawrence River at Cornwall, Ont. near Massena, N. Y.	298,800	126	296,600 (1975)	300,000 (1973)	337,900	136	342,000	(*)
06441500	Bad River near Fort Pierre, S. Dak.	3,107	58	12.5 (1977)	146 (1956)	15.8	52,667	35	24
06630000	North Platte River above Seminole Reservoir, near Sinclair, Wyo.	4,175	47	750 (1984)	991 (1961)	750	197	959	18
06800500	Elkhorn River at Waterloo, Nebr.	6,900	66	1,850 (1982)	6,740 (1982)	2,180	369	3,140	9
09180500	Colorado River near Cisco, Utah	24,100	75	6,891 (1984)	7,610 (1941)	7,091	196	9,930	2
09315000	Green River at Green River, Utah	44,850	87	6,376 (1982)	8,710 (1957)	6,461	233	7,000	23
09379500	San Juan River near Bluff, Utah	23,000	72	3,899 (1965)	6,120 (1965)	4,611	525	9,170	3

\*Occurred more than once.



## FLOW OF LARGE RIVERS IN THE MIDCONTINENT

Unshaded area indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period.



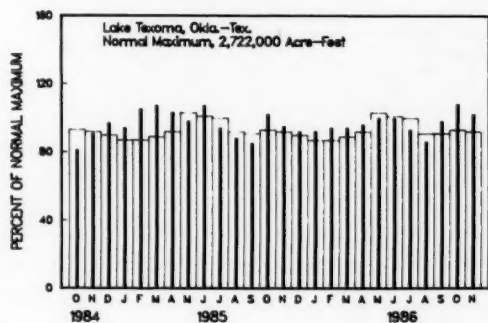
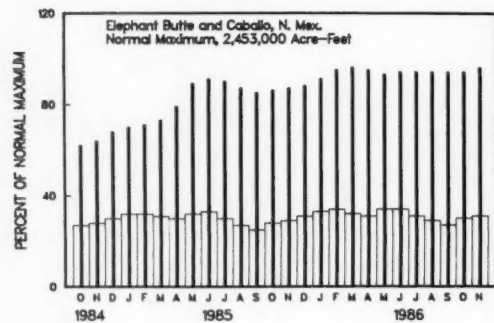
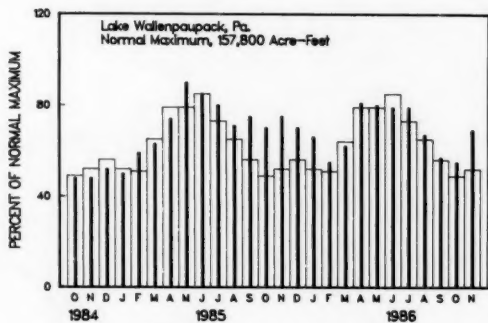
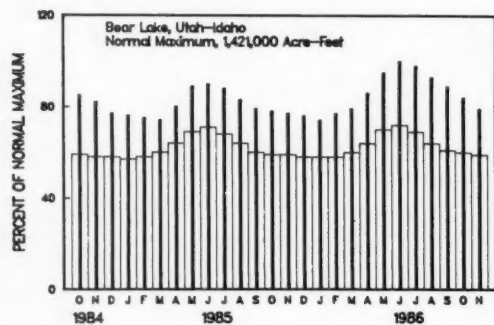
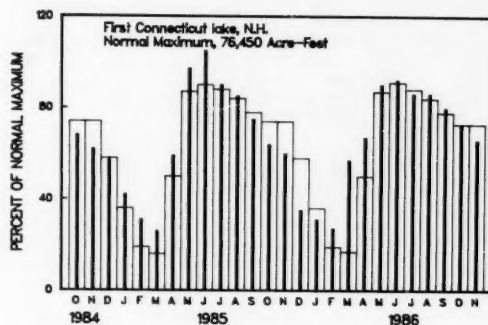
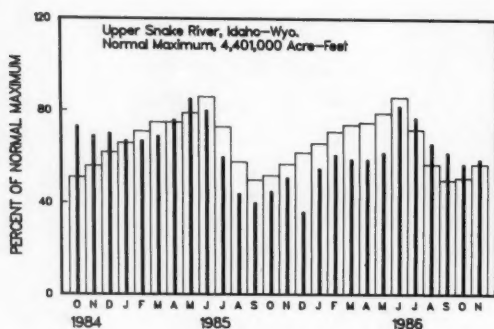
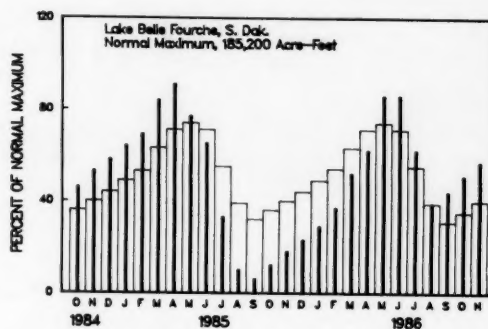
## FLOW OF LARGE RIVERS DURING NOVEMBER 1986

Station number	Stream and place of determination	Drainage area (square miles)	Average discharge through September 1980 (cubic feet per second)	November 1986					
				Monthly mean discharge (cubic feet per second)	Percent of median monthly discharge, 1951-80	Change in discharge from previous month (percent)	Discharge near end of month		
							Cubic feet per second	Million gallons per day	Date
01014000	St. John River below Fish River at Fort Kent, Maine	5,690	9,647	5,530	78	-42	3,000	1,900	30
01318500	Hudson River at Hadley, N.Y.	1,664	2,909	2,500	104	-7	3,590	2,320	30
01357500	Mohawk River at Cohoes, N.Y.	3,456	5,734	9,230	194	+84	12,600	8,140	30
01463500	Delaware River at Trenton, N.J.	6,780	11,750	13,590	138	+234	34,500	22,300	29
01570500	Susquehanna River at Harrisburg, Pa.	24,100	34,530	47,160	191	+216	124,900	80,720	30
01646500	Potomac River near Washington, D.C.	11,560	11,490	14,410	99	+153	7,070	4,569	30
02105500	Cape Fear River at William O. Huske Lock near Tarheel, N.C.	4,810	5,005	1,343	69	+37	1,700	1,100	30
02131000	Pee Dee River at Peedee, S.C.	8,830	9,851	4,740	105	+114	7,550	4,879	26
02226000	Altamaha River at Doctortown, Ga.	13,600	13,880	4,201	84	+114	7,490	4,840	30
02320500	Suwannee River at Branford, Fl.	7,880	6,987	2,720	82	-7	2,800	1,810	30
02358000	Apalachicola River at Chattahoochee, Fl.	17,200	22,570	8,030	72	+54	10,000	6,000	30
02467000	Tombigbee River at Demopolis lock and dam near Coatopa, Ala.	15,400	23,300	25,690	407	+414	92,000	59,500	30
02489500	Pearl River near Bogalusa, La.	6,630	9,768	7,865	307	+279	33,600	21,720	30
03049500	Allegheny River at Natrona, Pa.	11,410	19,480	19,320	141	-5	23,800	15,380	24
03085000	Monongahela River at Braddock, Pa.	7,337	12,510	12,670	340	+186	34,200	22,100	22
03193000	Kanawha River at Kanawha Falls, W.Va.	8,367	12,590	12,330	156	+161	9,560	6,178	23
03234500	Scioto River at Higby, Ohio.	5,131	4,547	4,363	269	-14	14,500	9,370	30
03294500	Ohio River at Louisville, Ky. <sup>2</sup>	91,170	116,000	134,400	215	+55	152,300	98,430	25
03377500	Wabash River at Mount Carmel, Ill.	28,635	27,220	12,100	109	-40	24,200	15,640	30
03469000	French Broad River below Douglas Dam, TN.	4,543	6,798	4,457	95	+131	...	...	...
04084500	Fox River at Rapide Croche Dam, near Wrightstown, Wis. <sup>2</sup>	6,150	4,163	5,665	162	-57	4,782	3,090	30
04264331	St. Lawrence River at Cornwall, Ontario-near Massena, N.Y. <sup>3</sup>	298,800	242,700	337,900	136	+4	339,000	219,100	30
02NG001	St. Maurice River at Grand Mere, P.Q.	16,300	25,150	16,700	92	-47	19,600	12,670	28
05082500	Red River of the North at Grand Forks, N.Dak.	30,100	2,551	2,009	159	-40	2,450	1,583	25
05133500	Rainy River at Manitou Rapids, Minn...	19,400	11,830	10,000	102	+20	10,200	6,590	20
05330000	Minnesota River near Jordan, Minn.	16,200	3,402	6,529	726	-52	4,800	3,100	30
05331000	Mississippi River at St. Paul, Minn.	36,800	10,610	18,540	295	-51	15,700	10,150	30
05365500	Chippewa River at Chippewa Falls, Wis.	5,600	5,100	4,817	125	-52	3,520	2,275	30
05407000	Wisconsin River at Muscoda, Wis.	10,300	8,617	9,302	142	-63	8,512	5,501	30
05446500	Rock River near Joslin, Ill.	9,551	5,873	8,970	237	-48	8,300	5,360	30
05474500	Mississippi River at Keokuk, Iowa.	119,000	62,620	94,140	205	-56	85,600	55,320	30
06214500	Yellowstone River at Billings, Mont.	11,796	7,038	4,540	117	-10	4,390	2,837	26
06934500	Missouri River at Hermann, Mo.	524,200	79,490	146,600	268	-49	126,000	81,400	29
07289000	Mississippi River at Vicksburg, Miss. <sup>4</sup>	1,140,500	576,600	804,100	251	-11	704,000	455,000	28
07331000	Washita River near Dickson, Okla.	7,202	1,368	4,771	1211	-28	3,500	2,260	30
08276500	Rio Grande below Taos Junction Bridge, near Taos, N.Mex.	9,730	725	1,325	316	+50	1,380	891	30
09315000	Green River at Green River, Utah.	44,850	6,298	6,461	233	+9	...	...	...
11425500	Sacramento River at Verona, Calif.	21,257	18,820	10,316	79	-19	11,200	7,240	30
13269000	Snake River at Weiser, Idaho.	69,200	18,050	21,200	141	-9	24,200	15,640	30
13317000	Salmon River at White Bird, Idaho.	13,550	11,250	5,270	102	-6	5,130	3,315	30
13342500	Clearwater River at Spalding, Idaho.	9,570	15,480	7,490	148	+75	5,310	3,431	27
14105700	Columbia River at The Dalles, Oreg. <sup>5</sup>	237,000	193,100	193,400	106	-24	126,500	81,760	30
14191000	Willamette River at Salem, Oreg.	7,280	123,510	137,900	142	+450	95,800	61,920	30
15515500	Tanana River at Nenana, Alaska.	25,600	23,460	9,600	115	-50	7,300	4,720	30
08MF005	Fraser River at Hope, B.C.	83,800	96,290	45,900	78	-13	44,840	28,980	28

<sup>1</sup>Adjusted.<sup>2</sup>Records furnished by Corps of Engineers.<sup>3</sup>Records furnished by Buffalo District, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y. when adjusted for storage in Lake St. Lawrence.<sup>4</sup>Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.<sup>5</sup>Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

[NOTE: Drainage areas of St. Lawrence River at Cornwall, Ont., and Green River at Green River, Utah, have been corrected.]

# USABLE CONTENTS OF SELECTED RESERVOIRS AND RESERVOIR SYSTEMS

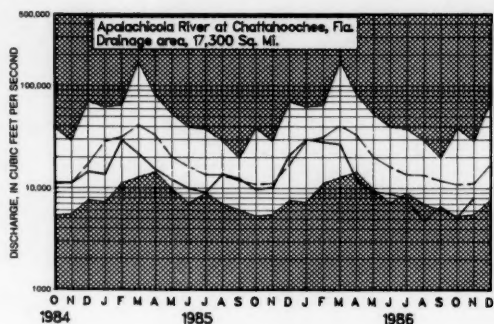
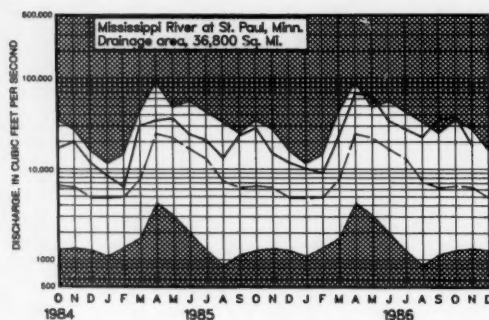
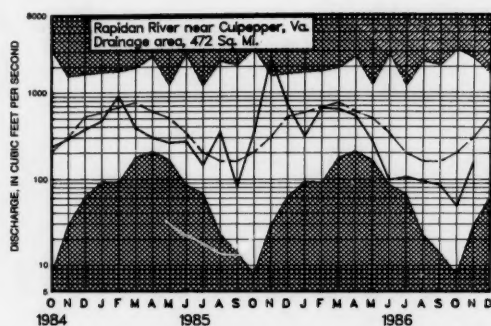
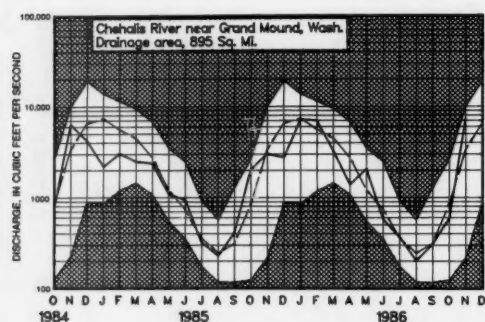


Principal uses: F-Flood control I-Irrigation M-Municipal P-Power R-Recreation W-Industrial	Percent of normal maximum				Normal maximum (acre-feet)	Principal uses: F-Flood control I-Irrigation M-Municipal P-Power R-Recreation W-Industrial	Percent of normal maximum				Normal maximum (acre-feet)
	End of Nov. 1986	End of Nov. 1985	Average for end of Nov.	End of Oct. 1986			End of Nov. 1986	End of Nov. 1985	Average for end of Nov.	End of Oct. 1986	
<b>NOVA SCOTIA</b>						<b>NEBRASKA</b>					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Pothook Reservoirs(P).....	36	22	40	41	<sup>b</sup> 226,300	Lake McConaughy (IP).....	80	77	68	78	1,948,000
<b>QUEBEC</b>						<b>OKLAHOMA</b>					
Allard (P).....	82	89	62	79	280,600	Eufaula (FRP).....	104	104	90	124	2,378,000
Gouin (P).....	94	78	69	93	6,954,000	Keystone (FPR).....	97	137	98	149	661,000
<b>MAINE</b>						Tenkiller Ferry (FPR).....	113	113	99	139	628,200
Seven reservoir systems (MP).....	55	56	56	57	4,107,000	Lake Altus (FIMR).....	100	16	44	100	133,000
<b>NEW HAMPSHIRE</b>						Lake O'The Cherokees (FPR).....	96	122	83	111	1,492,000
First Connecticut Lake (P).....	66	60	73	73	76,450	<b>OKLAHOMA-TEXAS</b>					
Lake Francis (FPR).....	78	88	78	82	99,310	Lake Texoma (FMPRW).....	102	95	92	108	2,722,000
Lake Winnepesaukee (PR).....	68	65	59	72	165,700	<b>TEXAS</b>					
<b>VERMONT</b>						Bridgeport (IMW).....	92	81	47	92	386,400
Harrison (P).....	81	86	65	69	116,200	Canyon (FMR).....	97	99	77	104	385,600
Somerset (P).....	88	85	71	78	57,390	International Amistad (FIMPW).....	82	73	85	81	3,497,000
<b>MASSACHUSETTS</b>						International Falcon (FIMPW).....	54	39	76	47	2,668,000
Cobble Mountain and Borden Brook (MP).....	70	73	72	69	77,920	Livingston (IMW).....	104	106	86	101	1,788,000
<b>NEW YORK</b>						Roscoe Reservoir (IMPRW).....	95	92	98	97	570,200
Great Sacandaga Lake (FPR).....	66	73	56	74	786,700	Red Bluff (P).....	69	62	77	83	307,000
Indian Lake (FMP).....	69	94	60	73	103,300	Toledo Bend (P).....	85	92	81	85	4,472,000
New York City reservoir system (MW).....	84	65	65	74	1,680,000	Twin Buttes (FIM).....	43	12	29	41	177,800
<b>NEW JERSEY</b>						Lake Kemp (IMW).....	102	93	86	124	268,000
Wanaque (M).....	68	93	66	60	85,100	Lake Meredith (FWM).....	29	30	38	27	796,900
<b>PENNSYLVANIA</b>						Lake Travis (FIMPRW).....	100	88	78	105	1,144,000
Allegheny (FPR).....	35	50	35	38	1,180,000	<b>MONTANA</b>					
Pymatuning (FMR).....	80	104	80	85	188,000	Canyon Ferry (FIMPR).....	87	79	89	89	2,043,000
Lake Kalamoon Lake (FR).....	67	68	53	65	761,900	Fort Peck (FPR).....	85	75	85	85	18,910,000
Lake Wallenpaupack (PR).....	69	75	52	55	157,800	Hungry Horse (FIPR).....	80	82	84	80	3,451,000
<b>MARYLAND</b>						<b>WASHINGTON</b>					
Baltimore municipal system (M).....	60	72	83	55	261,900	Ross (PR).....	88	82	79	89	1,052,000
<b>NORTH CAROLINA</b>						Franklin D. Roosevelt Lake (IP).....	99	84	100	99	5,022,000
Bridgewater (Lake James) (P).....	95	94	78	92	288,800	Lake Chelan (PR).....	71	73	65	83	676,100
Narrows (Badin Lake) (P).....	84	97	92	84	128,900	Lake Cushman (PR).....	55	53	82	55	359,500
High Rock Lake (P).....	55	83	55	58	234,800	Lake Merwin (P).....	99	92	91	104	245,600
<b>SOUTH CAROLINA</b>						<b>IDAHO</b>					
Lake Murray (P).....	85	82	61	83	1,614,000	Boise River (4 reservoirs) (FIP).....	53	53	54	54	1,235,000
Lakes Marion and Moultrie (P).....	83	86	64	83	1,862,000	Coeur d'Alene Lake (P).....	67				

<sup>b</sup>Thousands of kilowatt-hours (the potential electric power that could be generated by the volume of water in storage).

## MONTHLY MEAN DISCHARGE OF SELECTED STREAMS

Unshaded area indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period.

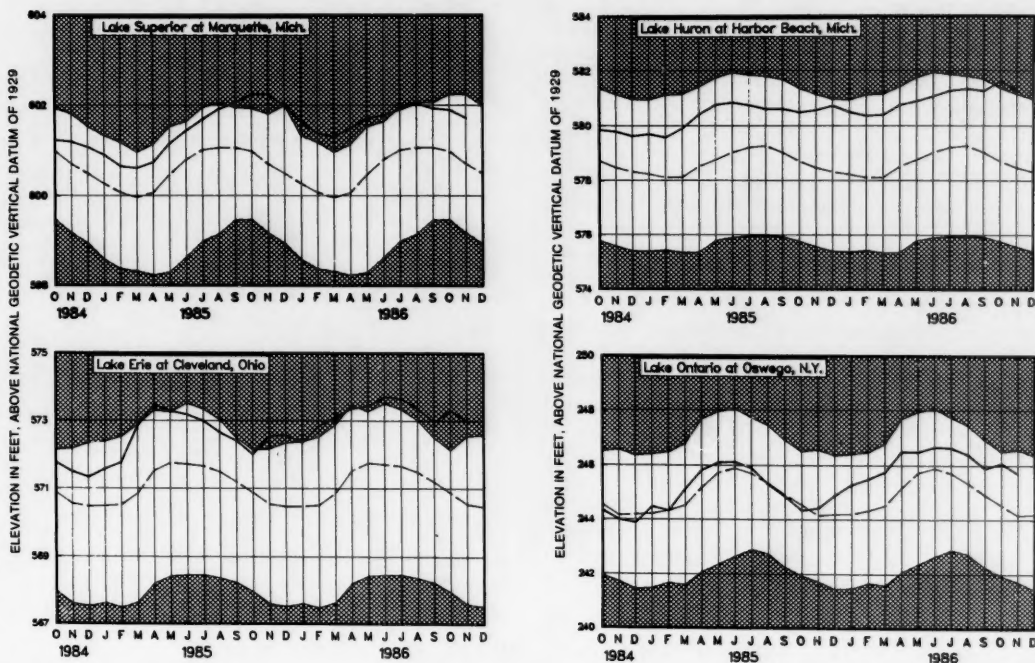


## SUMMARY OF STREAMFLOW CONDITIONS AT INDEX GAGING STATIONS

Area	Number of sites reporting data	Flow Ranges					
		Below Normal		Normal		Above Normal	
		Sites	Percent	Sites	Percent	Sites	Percent
Conterminous United States.	164	13	7.9	70	42.7	81	49.4
Alaska, Hawaii, and Puerto Rico.	10	...	...	4	40.0	6	60.0
United States and Puerto Rico.	174	13	7.5	74	42.5	87	50.0
Southern Canada.....	18	5	27.8	11	61.1	2	11.1
Conterminous United States and southern Canada.	182	18	9.9	81	44.5	83	45.6
All sites.....	192	18	9.4	85	44.3	89	46.3

## GREAT LAKES ELEVATIONS

Unshaded area indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period. Data from National Weather Service.



range for 16 months. Flows of the other four midcontinent rivers have been more variable: Missouri River at Herman, Missouri, has been in the normal to above-normal range for all 26 months; Rainy River at Manitou Rapids, Minnesota, has been in the normal to above-normal range for 25 of 26 months; Mississippi River at Vicksburg, Mississippi, has been in the normal to above-normal range for 24 of 26 months (April and May 1986 were below normal); Ohio River at Louisville, Kentucky, has been in the normal to above-normal range for 23 of 26 months (January, April, and May 1986 were below normal).

Streamflow conditions at four sites across the United States are shown by the hydrographs on page 10: Chehalis River near Grand Mound, Washington, went from below normal in October to above normal in November as a result of the heavy rains in the Pacific Northwest during November; Rapidan River near Culpeper, Virginia, has been below normal for 5 of the last 7 months; (Mississippi River at St. Paul, Minnesota, was discussed previously); Apalachicola River at Chattahoochee, Florida, has been

below normal for the last eight consecutive months and was also below normal during much of the 1985 water year.

Utah's Great Salt Lake remained at elevation 4,210.95 feet above National Geodetic Vertical Datum of 1929 from November 1-15, but rose to 4,211.05 feet by November 30, only 0.80 foot below the maximum of record reached June 3-8, 1986.

Great Lakes monthly average levels for November (provisional data from National Weather Service) remained well above median on all of the lakes as shown by the four hydrographs (Lake Huron and Lake Michigan are represented by the Lake Huron gage) above. Lake Huron (581.29 feet) and Lake Erie (573.01 feet) both were at record high average levels (above National Geodetic Vertical Datum of 1929) for November; Lake Superior, which set new monthly average record highs from October 1984 through June 1986, averaged 601.72 feet, 0.52 foot below the record average set in November 1985; Lake Ontario averaged 245.69 feet, 1.53 feet above last November but 0.87 foot below the November record high.

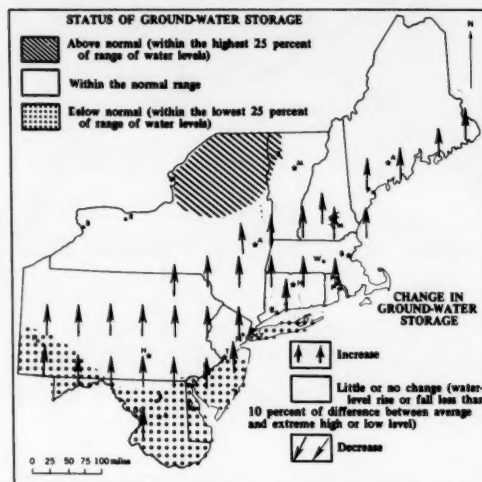
## GROUND-WATER CONDITIONS DURING NOVEMBER 1986

Ground-water levels generally rose in most of the Northeast. (See map.) Levels declined at least slightly in parts of northern New England and in Delaware and southern New Jersey. Below-average water-level conditions persisted in southern New Jersey, Delaware, Maryland, and on Long Island, New York; levels remained above average in northeastern New York. Ground-water levels were near average in most of the remainder of the Northeast.

In the Southeastern States, ground-water levels rose in Mississippi, and also in most observation wells in West Virginia. Water levels declined in Virginia with trends mixed in other Southeastern States. Water levels were above average in Kentucky, and below average in Virginia, Arkansas, Louisiana, and Florida. Levels were mixed with respect to average in West Virginia and North Carolina. A new high water level for November was reached in the Glenville observation well in West Virginia. New November low levels were recorded in the key wells at Memphis, Tennessee, and on Cockspur Island in the Savannah area, Chatham County, Georgia, despite net rises in both wells during the month.

In the central and western Great Lakes States, ground-water levels rose in Ohio, declined in Wisconsin, Michigan, and Indiana, and mostly declined in Iowa. Water levels showed mixed trends in Minnesota. Water

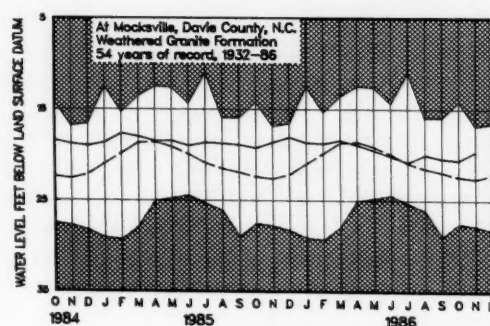
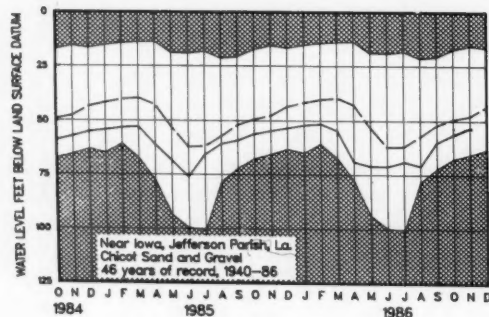
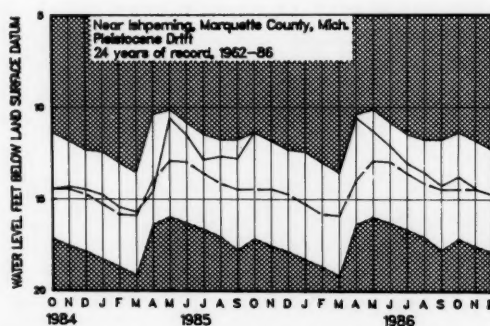
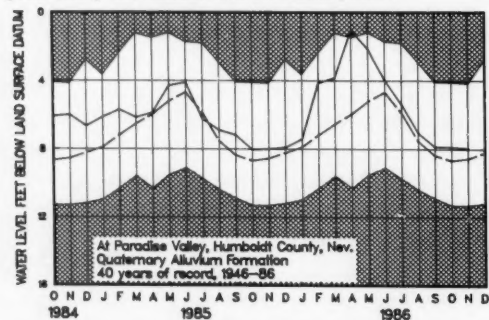
levels were above average in Iowa, and mixed with respect to average in other States. New November high levels, despite net declines during the month, were reported for



Map showing ground-water storage near end of November and change in ground-water storage from end of October to end of November.

## MONTH-END GROUND-WATER LEVELS IN KEY WELLS

Unshaded area indicates range between highest and lowest record for the month. Dashed line indicates average of monthly levels in previous years. Heavy line indicates level for current period.



key wells in the northern and south-central parts of Michigan's Lower Peninsula for the second consecutive month.

In the Western States, ground-water levels rose in North Dakota, New Mexico, and Texas, and declined in most of the key wells in Idaho. Trends were mixed in other Western States. Water levels were above average in North Dakota and Nebraska. Levels were mixed with respect

to average in other States. New high ground-water levels for November were recorded at wells in North Dakota, Nebraska, Nevada, and Kansas. New November low levels were reported, despite net rises at wells in Nevada, Kansas, and Texas. The level in the Berrendo-Smith observation well, in the Roswell artesian basin of the Pecos Valley in New Mexico, rose more than 2 feet to a new all-time high in 20 years of record.

Provisional data; subject to revision

# **WATER LEVELS IN KEY OBSERVATION WELLS IN SOME REPRESENTATIVE AQUIFERS IN THE CONTERMINOUS UNITED STATES—NOVEMBER 1986**

Aquifer and Location	Water level in feet with reference to land-surface datum	Departure from average in feet	Net change in water level in feet since:		Year records began	Remarks
			Last month	Last year		
Glacial drift at Hanska, south-central Minnesota.	-5.26	+3.07	-0.45	-0.04	1942	
Glacial drift at Roscommon in north-central part of Lower Peninsula, Michigan.	-3.87	+1.01	-0.45	+0.17	1935	Nov. high.
Glacial drift at Marion, Iowa .....	-3.32	+3.19	-0.37	-0.11	1941	
Glacial drift at Princeton in northwestern Illinois.	-8.0	+6.2	-0.1	-1.8	1943	
Petersburg Granite, southeastern Piedmont near Fall Zone, Colonial Heights, Virginia.	-16.83	-0.54	-0.32	-3.04	1939	
Glacial outwash sand and gravel, Louisville, Kentucky (U.S. well no. 2).	-18.15	+7.17	-0.05	-1.17	1946	
500-foot sand aquifer near Memphis, Tennessee (U.S. well no. 2).	-105.53	-15.91	+0.63	+1.06	1941	Nov. low.
Granite in eastern Piedmont Province, Chapel Hill, North Carolina (U.S. well no. 5).	-45.71	-2.32	-0.48	-2.32	1931	
Sparta Sand in Pine Bluff industrial area, Arkansas.	-223.95	-18.16	-2.55	-8.25	1958	
Eutaw Formation in the City of Montgomery, Alabama (U.S. well no. 4).	-25.1	-2.1	+2.0	-3.3	1952	
Limestone aquifer on Cockspur Island, Savannah area, Georgia (U.S. well no. 6).	-35.85	-8.78	+0.71	-1.63	1956	Nov. low.
Sand and gravel in Puget Trough, Tacoma, Washington.	-102.46	+7.19	+0.66	+0.24	1952	
Pleistocene glacial outwash gravel, North Pole, northern Idaho (U.S. well no. 3).	-463.1	-2.8	-0.7	-3.5	1929	
Snake River Group: Snake River Plain Aquifer, at Eden, Idaho (U.S. well no. 4).	-118.4	-2.5	-0.3	...	1957	
Alluvial valley fill in Flowell area, Millard County, Utah (U.S. well no. 9).	-6.50	+22.26	+0.98	-1.68	1929	
Alluvial sand and gravel, Platte River Valley, Ashland, Nebraska (U.S. well no. 6).	-2.20	+4.08	-1.37	+3.60	1935	Nov. high.
Alluvial valley fill in Steptoe Valley, Nevada....	-7.70	+5.29	+0.34	+0.45	1950	Nov. high.
Pleistocene terrace deposits in Kansas River valley, at Lawrence, northeastern Kansas.	-15.10	+5.65	+0.47	+0.56	1953	Nov. high.
Alluvium and Paso Robles clay, sand, and gravel, Santa Maria Valley, California	-117.30	+26.09	+1.70	-10.01	1957	
Valley fill, Elfrida area, Douglas, Arizona (U.S. well no. 15).	-103.5	-22.8	+0.5	+1.5	1951	
Hueco bolson, El Paso area, Texas.....	-266.15	-19.03	+0.98	-1.71	1965	Nov. low.
Evangelina aquifer, Houston area, Texas.....	-315.60	-11.57	+2.62	-0.42	1965	

# DISSOLVED SOLIDS AND WATER TEMPERATURES, FOR NOVEMBER 1986, AT DOWNSTREAM SITES ON FIVE LARGE RIVERS

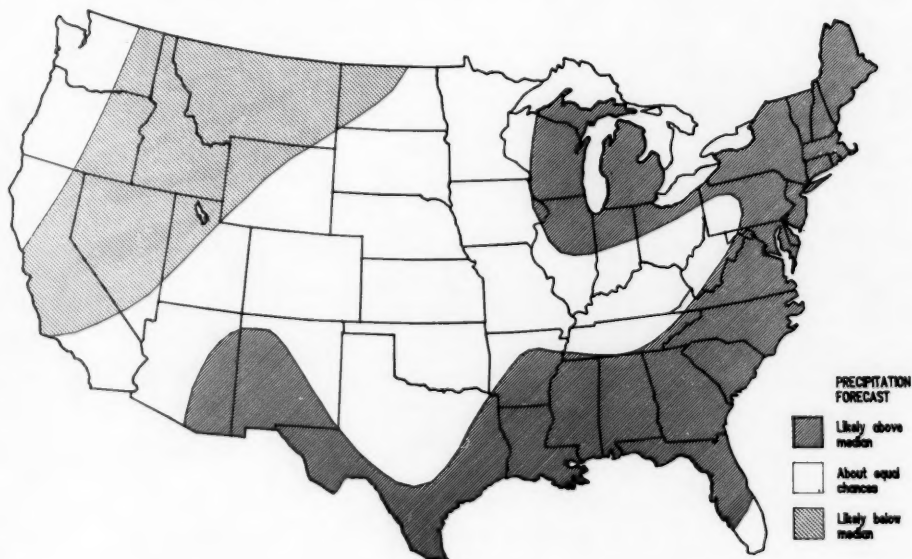
Station number	Station name	November data of following calendar years	Stream discharge during month	Dissolved-solids concentration <sup>a</sup>		Dissolved-solids discharge <sup>a</sup>			Water temperature <sup>b</sup>		
				Minimum (mg/L)	Maximum (mg/L)	Mean	Minimum	Maximum	Mean in °C	Minimum in °C	Maximum in °C
			Mean (cfs)	(tons per day)							
01463500	Delaware River at Trenton, NJ (Morrisville, PA).	1986	13,590	68	124	3,140	994	7,750	7.5	4.0	13.0
		1944—85 (Extreme yr)	9,988	55 (1955)	151 (1964)	...	469 (1963)	12,300 (1972)	...	2.0	19.0
			<sup>c</sup> 9,825								
07289000	Mississippi River at Vicksburg, MS.	1986	804,100	230	245	511,700	434,000	574,600	13.0	9.0	16.5
		1975—85 (Extreme yr)	458,500	181 (1984)	305 (1983)	294,400	123,000 (1976)	677,800 (1985)	13.5	8.0	20.0
			<sup>c</sup> 320,600								
03612500	Ohio River at lock and dam 53, near Grand Chain, IL (streamflow station at Metropolis, IL).	1986	216,000	164	260	...	13,900	276,000	...	11.0	18.5
		1954—85 (Extreme yr)	181,600	129 (1957)	425 (1968)	...	27,200 (1954)	406,000 (1957)	...	1.0	19.5
			<sup>c</sup> 147,600								
06934500	Missouri River at Hermann, MO (60 miles west of St. Louis, MO).	1986	147,000	312	506	144,000	128,000	164,000	7.0	5.5	9.0
		1975—85 (Extreme yr)	87,590	204 (1985)	506 (1980)	88,940	43,600 (1976)	246,000 (1985)	9.5	3.5	15.0
			<sup>c</sup> 54,680								
14128910	Columbia River at Warrendale, OR (streamflow station at The Dalles, OR).	1986	141,000	105	119	43,000	32,800	53,200	11.5	9.0	13.5
		1975—85 (Extreme yr)	133,600	38 (1980)	128 (1978)	37,300	10,800 (1980)	66,400 (1978)	11.0	3.0	14.5
			<sup>c</sup> 87,960								

<sup>a</sup>Dissolved-solids concentrations, when not analyzed directly, are calculated on basis of measurements of specific conductance.

<sup>b</sup>To convert °C to °F: [(1.8 X °C) + 32] = °F.

<sup>c</sup>Median of monthly values for 30-year reference period, water years 1951—80, for comparison with data for current month.

## PRECIPITATION OUTLOOK FOR DECEMBER 1986 THROUGH FEBRUARY 1987



(From Monthly and Seasonal Weather Outlook Published by National Weather Service)

## NATIONAL WATER CONDITIONS December 1986

Based on reports from the  
Canadian and U.S. Field offices;  
completed December 15, 1986

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### EXPLANATION OF DATA (Revised August 1986)

*Cover map* shows generalized pattern of streamflow for the month based on provisional data from 184 index gaging stations—18 in Canada, 164 in the United States, and 2 in the Commonwealth of Puerto Rico. Alaska, Hawaii, and Puerto Rico inset maps show streamflow only at the index gaging stations that are located near the point shown by the arrows. Classifications on map are based on comparison of streamflow for the current month at each index station with the flow for the same month in the 30-year reference period, 1951–80. Shorter reference periods are used for one Canadian index station, two Kansas index stations, one New York index station, and the Puerto Rico index stations because of the limited records available.

The comparative data are obtained by ranking the 30 flows for each month of the reference period in order of decreasing magnitude—the highest flow is given a ranking of 1 and the lowest flow is given a ranking of 30. Quartiles (25-percent points) are computed by averaging the 7th and 8th highest flows (upper quartile), 15th and 16th highest flows (middle quartile and median), and the 23rd and 24th highest flows (lower quartile). The upper and lower quartiles set off the highest 25 percent of flows and lowest 25 percent of flows, respectively, for the reference period. The median (middle quartile) is the middle value by definition. For the reference period, 50 percent of the flows are greater than the median, 50 percent are less than the median, 50 percent are between the upper and lower quartiles (in the normal range) 25 percent are greater than the upper quartile (above normal), and 25 percent are less than the lower quartile (below normal). Flow for the current month is then classified as; *above normal* if it is greater than the upper quartile, *in the normal range* if it is between the upper and lower quartiles, and *below normal* if it is less than the lower quartile. Change in flow from the previous month to the current month is classified as *seasonal* if the change is in the same direction as the change in the median. If the change is in the opposite direction of the

change in the median, the change is classified as *contraseasonal* (opposite to the seasonal change). For example: at a particular index station, the January median is greater than the December median; if flow for the current January increased from December (the previous month), the increase is seasonal; if flow for the current January decreased from December, the decrease is *contraseasonal*.

*Flood frequency analyses* define the relation of flood peak magnitude to probability of occurrence or recurrence interval. *Probability of occurrence* is the chance that a given flood magnitude will be exceeded in any one year. *Recurrence interval* is the reciprocal of probability of occurrence and is the *average* number of years between occurrences. For example, a flood having a probability of occurrence of 0.01 (1 percent) has a recurrence interval of 100 years. *Recurrence intervals imply no regularity of occurrence*; a 100-year flood might be exceeded in consecutive years or it might not be exceeded in a 100-year period.

Statements about *ground-water levels* refer to conditions near the end of the month. The water level in each key observation well is compared with average level for the end of the month determined from the 30-year reference period, 1951–80, or from the entire past record for that well when only limited records are available. Comparative data for ground-water levels are obtained in the same manner as comparative data for streamflow. *Changes in ground-water levels*, unless described otherwise, are from the end of the previous month to the end of the current month.

Dissolved solids and temperature data for November are given for five stream-sampling sites that are part of the National Stream Quality Accounting Network (NASQAN). *Dissolved solids* are minerals dissolved in water and usually consist predominately of silica and ions of calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulfate, chloride, and nitrate. *Dissolved-solids discharge* represents the total daily amount of dissolved minerals carried by the stream. *Dissolved-solids concentrations* are generally higher during periods of low streamflow, but the highest dissolved-solids *discharges* occur during periods of high streamflow because the total quantities of water, and therefore total load of dissolved minerals, are so much greater than at times of low flow.

### METRIC EQUIVALENTS OF UNITS USED IN THE NATIONAL WATER CONDITIONS

- 1 foot = 0.3048 meter
- 1 acre-foot = 1,233 cubic meters
- 1 million cubic feet = 28,320 cubic meters
- 1 cubic foot per second =  
0.02832 cubic meters per second =  
1.699 cubic meters per minute
- 1 cubic foot per second · day = 2,447 cubic meters
- 1 mile = 1.609 kilometers
- 1 square mile = 259 hectares = 2.59 square kilometers
- 1 million gallons = 3,785 cubic meters =  
3.785 million liters
- 1 million gallons per day = 694.4 gallons per minute =  
2.629 cubic meters per minute =  
3,785 cubic meters per day

(Round-number conversions, to nearest four significant figures)

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